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Results of the Independent Radiological Verification Survey of Remediation at Building 14, Former Linde Uranium Refinery, Tonawanda, New York (LI001V)

S. P. McKenzie
M. S. Uziel

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S. P. McKenzie and M. S. Uziel

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Investigation Team
R. D. Foley – Measurement Applications and Development Manager
S. P. McKenzie – Survey Team Leader

Survey Team Members

R. L. Coleman	D. E. Rice
R. D. Foley	D. A. Roberts
R. C. Gosslee	R. E. Rodriguez
M. E. Murray	R. R. Rodriguez
V. P. Patania	J. Wade

Work performed by the
MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP
LIFE SCIENCES DIVISION

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
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ABSTRACT

As part of the Formerly Utilized Sites Remedial Action Program, a team from Oak Ridge National Laboratory (ORNL) conducted a radiological verification survey of Building 14 at the former Linde Uranium Refinery, Tonawanda, New York. The purpose of the survey was to verify that remedial action completed by the project management contractor had reduced contamination levels to within authorized limits. Prior to remediation, fixed and removable beta-gamma emitting material was prevalent throughout Building 14 and in some of the process piping. Decontamination consisted of removal of surface contamination from floors, floor-wall interfaces, walls, wall-ceiling interfaces, and overhead areas; decontamination or removal of process piping; excavation and removal of subsurface soil; and vacuuming of dust. This independent radiological assessment was performed to verify that the remedial action had reduced contamination levels to within authorized limits.

Building 14 at the former Linde site in Tonawanda, New York, was thoroughly investigated inside for radionuclide residues. Surface residual activity levels were generally well below applicable guidelines for protection against radiation. Similarly, removable alpha and beta-gamma activity levels were below guidelines. Gamma exposure rates within the building were at typical background levels, and no elevated indoor radon concentrations were measured.

However, numerous areas exceeding U.S. Department of Energy (DOE) applicable guidelines still remain inside and underneath the building. These areas were either (1) inaccessible or (2) removal was not cost-effective or (3) removal would affect the structural integrity of the building. These above-guideline areas have been listed, described, and characterized by the remediation subcontractor (Appendix A), and dose to an exposed worker during typical exposure scenarios has been calculated. Based on the remediation subcontractor's characterization data[1] and dose assessment calculations, these areas pose insignificant risk to building inhabitants under current use scenarios. However, future renovations, repairs, or demolition of the building must require prior evaluation and consideration of the areas.

Analysis of the project management contractor's post-remedial action data and results of this independent radiological verification survey by ORNL confirm that residual contamination inside the building is either below the limits prescribed by DOE applicable guidelines for protection against radiation or areas exceeding applicable guidelines have been characterized and a risk assessment completed. Building 14 can be released for unrestricted use under current use scenarios; however, arrangements must be made to inform current and future building owners of the locations of areas exceeding DOE guidelines and any associated restrictions concerning renovations, repairs, or demolition of the building.

[1]Radiological verification activities in these above-guideline areas were designated as outside the scope of the independent verification survey. No radiological survey activities were conducted in these areas by ORNL.

Results of the Independent Radiological Verification Survey of the Remediation at Building 14, Former Linde Uranium Refinery, Tonawanda, New York (LI001V)[1]

INTRODUCTION

From 1942 through approximately 1948, the Linde Air Products Division of Union Carbide Corporation, Tonawanda, New York, was one of many companies performing work associated with the development of nuclear energy for defense-related projects. This work was conducted under government contract to the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC). During the first 3 years, pitchblende ore from the Belgian Congo and concentrates from the Colorado Plateau ore were converted to U_3O_8. A second process yielding UO_2 was conducted for about a year, and a third process, converting UO_2 to green salt (UF_4), operated during World War II and the following 2 years. Linde also developed and produced barrier material for the Oak Ridge Gaseous Diffusion Plant. Other contracts have been identified, but the exact nature of the work involved is unknown (DOE 1980).

As a result of these and similar activities, equipment, buildings, and land at some of the sites became radiologically contaminated resulting in low levels of contamination on the properties. At contract termination, sites used by contractors were decontaminated in accordance with the standards and survey methods in use at that time. Since the original assessments, radiological criteria and guidelines for the release of such sites for unrestricted use have become more stringent. In some instances, records documenting decontamination efforts could not be found, and the final radiological conditions of the site could not be adequately determined. As a result, the Formerly Utilized Sites Remedial Action Program (FUSRAP) was established in 1974 to identify these formerly used sites and to reevaluate their radiological status (DOE 1980). The radiological survey detailed in this report was performed under the FUSRAP program.

The Linde site was investigated in October and November 1976 to determine the extent of on-site radiological contamination (DOE 1978). At that time, the investigation included direct measurements of alpha contamination and beta-gamma dose rates on floors, walls, ceilings, supports, and roof; collection of smear samples in the same locations to assess transferable contamination; measurement of external gamma levels; radiological analysis of exterior soil samples; and measurement of instantaneous radon concentrations. Because contamination in some areas was above limits set by then current federal guidelines for release of property for unrestricted use, the property was designated for remediation under FUSRAP (DOE 1978).

A remedial investigation/feasibility study–environmental impact statement process was conducted to obtain sufficient site-specific information for assessment of the nature and extent of contamination at the Tonawanda site and evaluation of remedial action alternatives (DOE 1993). This process included performing a characterization and identifying areas requiring additional investigation. Survey results at Building 14 indicated that most of the first floor contained fixed residual radioactivity exceeding U.S. Department of Energy (DOE) guidelines[2] with fixed-point beta-gamma measurements

[1]The survey was performed by members of the Measurement Applications and Development Group of the Life Sciences Division at Oak Ridge National Laboratory.

[2]DOE guidelines for total residual surface contamination in any one square meter for beta-gamma emitters: 5000 dpm/100 cm^2 averaged over 1 m^2 and 15,000 dpm/100 cm^2 maximum. (More details are given in Table 1.)

ranging from <720 to 280,000 dpm/100 cm^2. Dust from the basement stairwell contained 590 pCi/g ^{238}U. The second floor appeared to be free of contamination. Based on these results, Building 14 was scheduled for further investigation and remedial action.

In 1996, Bechtel National, Inc. (BNI), the project management contractor designated by the DOE, began remediation activities at Building 14. After significant effort by BNI, remediation activities were turned over to IDM Environmental Corporation, a turnkey remediation subcontractor under the supervision of BNI. When remediation in an area of the building was completed, an independent verification survey of the remediated area was conducted by the Measurement Applications and Development Group of ORNL. Under DOE, an independent verification contractor (IVC) was assigned to ensure the effectiveness of remedial activities performed within FUSRAP and to confirm compliance with applicable guidelines.

This report describes the independent radiological verification activities conducted intermittently by ORNL from March 1996 through January 1999 in connection with Building 14.The objectives of the verification activities were to confirm (1) that available documentation adequately and accurately described the post-remedial action status of the property that was to be verified, and (2) that remedial action reduced contamination levels to within authorized limits. Figure 1 shows the general location of the former Linde property in relation to other sites in Tonawanda. Figure 2 shows the location of Building 14 at the Linde site, and Fig. 3 show the basic floor plan of the building.

SCOPE OF THE INVESTIGATION

The radiological verification investigation included the following:

- Floor monitor[1] surveys of all smooth floor areas with further characterization of any suspect contamination with hand-held beta-gamma detectors.
- Beta-gamma scans of the building interior floor areas not appropriate for the floor monitor,[1] interior floor-wall interfaces, and interior walls up to ~10 ft.
- Beta-gamma scans of the horizontal surfaces associated with interior overhead areas, including I-beams, cross ties, ledges, and wall-ceiling interfaces where contamination would most likely be concentrated.
- Spot checks for contamination in additions and newly remodeled areas of the building.
- Measurement of transferable alpha and beta-gamma radiation levels at selected locations in the building.
- Collection and radiological analysis of soil samples from subsurface areas exposed after removal of the concrete floor and/or excavation of contaminated soil or after drilling through the concrete slab.
- Measurement of gamma exposure rates at 1 m above the surface, at the surface, and at depths of 6 and 12 in. at soil sample locations.
- Systematic measurements using thin window NaI detectors (FIDLER) at 2-m intervals in Areas 8, 10, and 11 and at 1-m intervals in Areas 20B and 20B-1.
- Measurement of indoor radon levels in several areas of the building using electret radon monitors.
- Examination of post-remedial action data collected by BNI and IDM Environmental Corporation and review of the post-remedial action report (BNI 1999).

A radiological survey of the building exterior and exterior surface soil and grounds in the vicinity of Building 14 was not within the scope of this investigation.

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[1] "Floor monitor" described in Survey Methods section.

SURVEY METHODS

A comprehensive description of the survey methods and instrumentation used in this survey is given in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (Myrick et al. 1987) and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (ORNL 1995).

Bicron miniscaler/ratemeters with Geiger-Mueller (GM) pancake detectors were used to measure beta-gamma radiation levels. Radiation levels in counts per minute (cpm) were converted to disintegrations per minute (dpm) per 100 cm^2. Gamma radiation levels were determined using portable sodium iodide (NaI) gamma scintillation counters connected to Victoreen Model 490 Thyac III ratemeters. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels in counts per minute were correlated to pressurized ionization chamber (PIC) measurements to determine gamma exposure rates in microroentgen per hour (FR/h) (Rodriguez et al. 1992).

Electret radon monitors manufactured by Rad Elec Inc. were used to measure radon concentrations in indoor air. The electret ion chamber contains an electrically charged Teflon™ disk that attracts ions produced by the decay of radon and its decay products. The attracted ions cause a reduction in the electret's surface voltage. When the electret charge is measured before and after deployment, the change in total charge over the elapsed time period is proportional to the cumulative radon exposure. (Only the radon present in the room air, and not the radon progeny, can enter the electret chamber. The subsequent decay of the radon and the progeny resulting inside the chamber produces the measured ionization.)

Bicron Model GJ FIDLER detectors connected to Ludlum 2221 scaler/ratemeters were used to measure the relative gamma fluence at the surface with the purpose of detecting gamma emitting radionuclide contamination beneath poured concrete floors. The FIDLER is a NaI(Tl) scintillation probe that is designed to be particularly sensitive to low-energy gamma and x-ray radiation. The sensitive volume is 5 in. in diameter by 0.063 in. thick and is very efficient at measuring gamma fluence rates entering perpendicular to the entrance window. The FIDLER is also sensitive to beta radiation and can be highly efficient for detecting this depending on the configuration used.

FIDLER measurements were not used for final verification purposes, but, rather, as a tool for further evaluation. FIDLER measurements were taken to assist IDM Environmental Corporation in selecting subsurface soil sampling locations. Measurements in counts per minute were taken with two different instruments. Because the results were not normalized, the observed values were compared only with other measurements taken with the same instrument.

Fifty-two systematic soil samples were collected at 49 locations after removal of the concrete slab and excavation of subsurface soil or after core drilling through concrete. Eighteen biased samples were collected at 17 locations. Systematic samples are taken from preselected or random grid locations irrespective of surface gamma exposure rates. Biased samples are collected at locations with slightly higher surface gamma exposure rates relative to surrounding areas. Concentrations of ^{238}U, ^{226}Ra, and ^{232}Th were determined in soil samples using gamma spectrometry with high-purity germanium (HPGe) systems.

Smooth floor areas of the building were surveyed with the Ludlum Model 239-1F gas flow proportional detector system ("floor monitor"), which includes a Ludlum Model 2221 scaler/ratemeter connected to a Ludlum Model 43-37 detector probe mounted on a roll-around cart. The monitor was set in the beta mode (high voltage setting) where it is primarily used to detect beta radiation, although it is also sensitive to alpha and gamma in this mode. Anomalies detected with the floor monitor were further characterized with the GM pancake detector. Questionable spots with elevated radiation levels

were sometimes analyzed on-site using a portable NaI gamma spectroscopy system. Gamma spectra were observed and compared to spectra of the radionuclides of concern.

Smear samples were obtained by wiping selected surfaces inside the building in order to assess removable alpha and beta-gamma activity levels. Samples were counted using a gross alpha smear counter and a gross beta smear counter.

A scissor lift and a man lift were used to access high overhead areas inside the building such as I-beams, cross ties, and ceiling-wall interfaces.

VERIFICATION SURVEY RESULTS

Applicable guidelines for protection against radiation are summarized in Table 1. Typical background radiation levels for the Tonawanda, New York, area are presented in Table 2. These data are provided for comparison with survey results presented in this section. Gamma radiation levels are presented in gross microroentgens per hour and FIDLER measurements in gross counts per minute. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil. Background count rates are subtracted in the conversion of alpha and beta-gamma count rates to disintegrations per minute per 100 cm^2 (dpm/100 cm^2).

In some instances, removal of the contamination or the contaminated structure would have affected the structural integrity of the building. In others, the contamination was inaccessible or removing it was not cost-effective. Therefore, the remediation subcontractor has listed, described, and characterized these areas in a "Summary of Locations Exceeding Remedial Action Criteria" (BNI 1999), provided in Appendix A. (Figure 5-1 of BNI 1999, which is not included in this report, shows more precisely the locations of these areas.) Independent verification surveys confirmed that the areas were above applicable guidelines and that the list was complete. Characterization data collected by the remediation subcontractor and subsequent dose assessment calculations for areas exceeding remedial action criteria were reviewed by the IVC but not verified.

PROCESS PIPING RADIOLOGICAL INVESTIGATION

Process lines throughout Building 14 were evaluated and characterized for radioactive contamination by the remediation subcontractor. The methods and procedures used to conduct this evaluation and characterization were discussed with and agreed upon by the IVC. The IVC also concurred with the findings of this investigation. The first section and Attachment 1 of *Summary Report for the Process Piping Radiological Investigation Praxiar Building 14* are provided in Appendix. B. [Additional attachments to this report (numbered 2–6) are not included in Appendix B.]

GAMMA RADIATION LEVELS

Gamma exposure rates in areas where the concrete floor had been removed and the exposed soil was being sampled are shown in Table 3. Gamma exposure rates in Building 14 generally ranged from 10 to 14 FR/h at 1 m above the soil surface and from 9 to 14 FR/h at the surface (Table 3). These levels are similar to typical background levels in the Tonawanda, New York, area (Table 2). Higher surface levels up to 18 FR/h were measured in exposed soil with elevated ^{238}U. Further excavation was conducted to remove additional soil when ^{238}U concentrations above guidelines were measured.

FIDLER MEASUREMENTS

Results of FIDLER measurements in Areas 8, 10, 11, 21B, and 20B-1 are shown in Appendix C. Measurements from each detector were compared with other measurements from the same detector to locate possible subsurface contamination and potential sampling locations for IDM.

SOIL SAMPLES

Soil sample locations are shown in Fig. 4, and results of radiological analyses are listed in Table 4. Concentrations of ^{238}U in surface soil (0–15 cm) ranged from 0.50 to 5.5 pCi/g at 41 sample locations and from 8.1 to 670 pCi/g at 25 locations; subsurface soil (15–30 cm) ranged from 44 to 195 pCi/g at four sample locations. Fourteen samples were above guideline values of 30 pCi/g for ^{238}U at this site. Further excavation of soil was conducted to remove uranium-contaminated soil in Areas 12, 13, 14A, and 20A after these soil samples were analyzed. Results from additional samples collected and analyzed by IDM were verified.

All accessible soil above guideline values was removed. In several areas, removing the soil would compromise the structural integrity of the building. In these cases, the areas were described, characterized, and listed by the remediation subcontractor (BNI 1999) in the "Summary of Locations Exceeding Remedial Action Criteria" (provided in Appendix A). Included in the list are soil underneath Area 12 west, east, and south walls; soil underneath Area 14N north wall and west wall; and soil underneath Area 14S west wall.

Concentrations of ^{226}Ra and ^{232}Th at soil sample locations (Table 4) ranged from 0.50 to 2.0 pCi/g and from 0.26 to 1.3 pCi/g, respectively, in 70 samples from 66 locations. These levels are similar to typical background levels of ^{226}Ra and ^{232}Th found in the Tonawanda area (Table 2).

SMEAR SAMPLE ANALYSIS

Results of smear sample analysis are given in Table 5. No removable (transferable) alpha or beta-gamma emitting material was measured in 21 smear samples collected in 5 different areas of Building 14. All samples were less than the minimum detectable activity (MDA) of the smear counters. Removable radioactivity levels were well below applicable guidelines (Table 1).

BETA-GAMMA ACTIVITY LEVELS

Results of the surface beta-gamma scans of the floors, walls, and overhead areas on both the first and the second floor are summarized in Table 6. Detailed survey drawings are on file. Table 6 also notes other verification activities conducted in each area (e.g., collection of soil samples or smear samples, results of gamma scans, review of data collected by the remediation subcontractor, etc.). The last column of Table 6 references correspondence (included in Appendix D) releasing the area as below the applicable guideline limits listed in Table 1. Total residual surface contamination limits for uranium in any one square meter (Table 1) are maximum 15,000 dpm/100 cm^2, average 5000 dpm/100 cm^2,

and removable 1000 dpm/100 cm^2. Therefore, an area with scan results ranging from 3400 to 6400 dpm/100 cm^2, is below guidelines if the average measurement is #5000 dpm/100cm^2 in any one square meter. Areas exceeding applicable guideline limits required further remediation.

As indicated by the survey results listed in Table 6, all areas not designated for inclusion in the "Summary of Locations Exceeding Remedial Action Criteria" (Appendix A) were below guideline limits on the date they were released by the verification contractor.

INDOOR RADON LEVELS

Twenty electret radon monitors were deployed for periods of 18 to 33 days at 17 locations between May, 28, 1998, and September 29, 1998. Sampling results are shown in Fig. 5 and Table 7. Radon concentrations in indoor air at Building 14 ranged from 0.4 to 1.6 pCi/L. All measurements were well below the EPA action level of 4 pCi/L.

SIGNIFICANCE OF FINDINGS

Prior to remediation, fixed and removable beta-gamma emitting material was prevalent throughout most of Building 14 and in some of the process piping. Decontamination, performed by BNI and subcontractors under the direction of BNI, consisted of removal of surface contamination from floors, floor-wall interfaces, walls, wall-ceiling interfaces, and overhead areas; decontamination or removal of process piping; excavation and removal of subsurface soil; and vacuuming of dust. This independent radiological verification survey was performed to verify that the remedial action had reduced contamination levels to within authorized limits.

Building 14 at the former Linde site in Tonawanda, New York, was thoroughly investigated inside for radionuclide residues. Surface residual activity levels were generally well below applicable guidelines for protection against radiation. Similarly, removable alpha and beta-gamma activity levels were below guidelines. Gamma exposure rates within the building were at typical background levels, and no elevated indoor radon concentrations were measured.

However, numerous areas exceeding DOE applicable guidelines still remain inside and underneath the building. These areas were either (1) inaccessible or (2) removal was not cost-effective or (3) removal would affect the structural integrity of the building. These above-guideline areas have been listed, described, and characterized by the remediation subcontractor (Appendix A), and dose to an exposed worker during typical exposure scenarios has been calculated. Based on the remediation subcontractor's characterization data[1] and dose assessment calculations, these areas pose insignificant risk to building inhabitants under current use scenarios. However, future renovations, repairs, or demolition of the building must require prior evaluation and consideration of the areas.

Analysis of the project management contractor's post-remedial action data (BNI 1999) and results of this independent radiological verification survey by ORNL confirm that residual contamination inside the building is either below the limits prescribed by DOE applicable guidelines for protection against radiation or areas exceeding applicable guidelines have been characterized and a risk assessment completed. Building 14 can be released for unrestricted use under current use scenarios; however, arrangements must be made to inform current and future building owners of the locations of areas

[1]Radiological verification activities in these above-guideline areas (see Appendix A) were designated as outside the scope of the independent verification survey. No radiological survey activities were conducted in these areas by ORNL.

exceeding DOE guidelines and any associated restrictions concerning renovations, repairs, or demolition of the building.

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Pages 8 through 12 (Figs. 1–5) provided in hard copy.

Table. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
	Indoor gamma	
Gamma radiation	Indoor gamma radiation level (above background)	20 FR/h[a]
	Surface contamination	
Total residual surface contamination in any one square meter [b]	^{238}U, ^{235}U, U-natural (alpha emitters)	
	or	
	Beta-gamma emitters[c]	
	Maximum	15,000 dpm/100 cm^2
	Average	5,000 dpm/100 cm^2
	Removable	1,000 dpm/100 cm^2
	^{232}Th, Th-natural (alpha emitters)	
	or	
	^{90}Sr (beta-gamma emitter)	
	Maximum	3,000 dpm/100 cm^2
	Average	1,000 dpm/100 cm^2
	Removable	200 dpm/100 cm^2
	^{226}Ra, ^{230}Th, transuranics	
	Maximum	300 dpm/100 cm^2
	Average	100 dpm/100 cm^2
	Removable	20 dpm/100 cm^2
	Radionuclides in soil	
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m^2 area	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface
	^{226}Ra	
	^{232}Th	
	^{230}Th	
Derived concentrations	Total uranium	60 pCi/g[d]

Table. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
	Soil hot spot criteria	
Guideline for non-homogeneous contamination (used in addition to the 100-m^2 guideline)[e]	Applicable to locations with an area #25 m^2, with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{½}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m^2 area

[a]The 20 FR/h shall comply with the basic dose limit (100 mrem/year) when an appropriate-use scenario is considered.

[b]These surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, May 1987.

[c]Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr, ^{228}Ra, ^{223}Ra, ^{227}Ac, ^{133}I, ^{129}I, ^{126}I, ^{125}I.

[d]Guidelines for uranium were derived by DOE on a site-specific basis. A total uranium guideline of 60 pCi/g will be applied at the former Linde site. This corresponds to a ^{238}U concentration of ~30 pCi/g.

[e]Guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

Sources: Adapted from U.S. Department of Energy, DOE Order 5400.5, April 1990; U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987; and U.S. Department of Energy, *Radiological Control Manual*, DOE/EH-0256T, April 1994.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil near Tonawanda, New York

Type of radiation measurement or sample	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at ground surface (FR/h)[a]	8–11	9
Concentration of radionuclides in soil (pCi/g)[a]		
^{238}U	0.8–1.1	1.0
^{226}Ra	0.7–1.1	0.9
^{232}Th	0.5–0.9	0.8

[a]Values obtained from four locations in the Tonawanda area.

Source: R. E. Rodriguez, M. E. Murray, and M. S. Uziel. October 1992. *Results of the Radiological Survey at the Town of Tonawanda Landfill, Tonawanda, New York (TNY001),* ORNL/RASA-92/12, Oak Ridge National Laboratory.

Table 3. Gamma exposure rates at soil sample locations, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Gamma exposure rate (FR/h)			Comments
			1 m above surface	Surface	depth of 6 in.	
			Systematic soil samples[c]			
VS139	13	F, 10	*d*	18	17	~3 ft below grade
VS140	13	I, 10	14	14	16	~3 ft below grade
VS141A	13	L, 10	14	18	20	~3 ft below grade
VS141B	13	L, 10	14	20[e]	19[f]	Refusal at depth of 11 in.
VS142A	13	P, 10	13	13	18	~2 ft below grade
VS142B	13	P, 10	13	18[e]	18[f]	Refusal at depth of 12 in.
VS143A	13	S, 10	13	14	18	~3 ft below grade
VS143B	13	S, 10	*d*	18[e]	18[f]	
VS144	13	V, 10	13	13	13	~3 ft below grade
VS145	13	V, 13	13	13	14	~2 ft below grade
VS146	13	S, 13	13	13	14	~2.5 ft below grade
VS147	13	P, 13	13	14	14	~3 ft below grade
VS148	13	L, 13	14	14	16	~3 ft below grade
VS149	13	I, 13	13	13	13	~3 ft below grade
VS150	13	P, 16	13	13	13	~2.5 ft below grade
VS151	13	S, 16	13	13	13	~2.5 ft below grade
VS152	13	V, 16	13	13	13	~2 ft below grade
VS153	12	G, 7	15	15	14	~3 ft below grade
VS154	12	I+0.5, 7	14	14	15	~3 ft below grade
VS155	12	L, 7	14	14	14	~3 ft below grade
VS156	12	P, 7	13	13	13	~3 ft below grade
VS157	12	L, 4	14	14	13	~3 ft below grade
VS158	12	I, 4	13	14	14	~3 ft below grade
VS159	12	G, 4	13	13	13	~3 ft below grade
VS160	12	I, 1	13	14	14	~3 ft below grade
VS161	12	P, 1	13	14	15	~3 ft below grade
VS162	12	T, 1	13	14	14	~3 ft below grade
VS163	14N	C, 1	13	13	13	~4.5 ft below grade

Table 3. Gamma exposure rates at soil sample locations, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Gamma exposure rate (FR/h)			Comments
			1 m above surface	Surface	depth of 6 in.	
VS164	14N	G, 1	13	13	14	~4.5 ft below grade
VS165	14A	L, 1	13	13	13	~4 ft below grade
VS166	14N	L, 5	13	13	13	~4 ft below grade
VS167	14N	G, 5	13	13	13	~4 ft below grade
VS168	14N	C, 5	13	13	14	~3 ft below grade
VS169	14N	C, 9	12	12	13	~2 ft below grade
VS170	14N	L, 9	13	13	13	~4 ft below grade
VS172	14N	G, 13	13	13	13	~3 ft below grade
VS173	14N	C, 14	11	13	13	~4 ft below grade
VS174	14N	C, 17	12	13	13	~2 ft below grade
VS175	14N	G, 17	13	13	13	~3 ft below grade
VS176	14N	L, 17	13	13	14	~2 ft below grade
VS 177	14S	F, 1.5	13	13	13	~4 ft below grade
VS178	14S	D, 7	12	12	*g*	~4 ft below grade, rocky, water at 6 in.
VS179	14S	I, 2	13	13	13	~3 ft below grade
VS180	9	B, 10	13	14	14	~18 in. below grade
VS181	9	H, 6	13	13	13	~18 in. below grade
VS182	9A	M, 2	13	13	10	
VS183	14S	C,10	12	13	13	~3 ft below grade
VS184	14S	F, 11	12	12	*d*	~2 ft below grade
VS185	14S	I, 14	10	9	*d*	~1 ft below grade
VS186	14S	B, 19	11	12	13	~2.5 ft below grade
VS187	14S	B, 13.5	12	12	13	~2.5 ft below grade
			Biased soil samples[1]			
VB23	20A	N (-4), E18	13	18	16	~Sample taken below 5-in. concrete slab
VB24	20A	N0, E17	12	13	13	~Sample taken below 12-in. concrete slab

Table 3. Gamma exposure rates at soil sample locations, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Gamma exposure rate (FR/h)			Comments
			1 m above surface	Surface	depth of 6 in.	
VB25	20A	N0, E12	11	12	13	~Sample taken below 12-in. concrete slab
VB26	20A	N0, E7	11	13	12[h]	~Sample taken below 12-in. concrete slab
VB27	20A	N0, E1	11	11	13[h]	~Sample taken below 12-in. concrete slab
VB28	20A	N1, E3	*d*	*d*	*d*	~2.5 ft below grade
VB29	20A	N1, E18	*d*	*d*	*d*	~2 ft below grade
VB30	13	L, 12.5	13	14	16	~3 ft. below grade
VB31	13	H, 15	13	14	16	~3 ft below grade
VB32	12	L, 1	14	18	18	~3 ft below grade
VB33A	12	W, 0	13	14	18	~4 ft below grade
VB33B	12	W, 0	13	18[e]	18[f]	
VB34	12	N, 3.5	13	14	14	~3 ft below grade
VB40	14A	G, 5	13	14	15	~4 ft below grade
VB41	14A	I, 5	13	14	14	~4 ft below grade
VB42	14N	K, 12.5	13	13	14	~2.5 ft below grade
VB43	9C	C, 1	13	23	20	
VB45	14SE	D, 15	*d*	13	13	~2 ft below grade; scraped into wall to depth of ~3 in.

[a]Sample locations are shown on Fig. 4.

[b]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0). In most rooms the number of meters north is indicated by a letter (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and the number of meters east by a number.

[c]Systematic samples were collected in a systematic manner without regard to gamma radiation levels.

[d]Not recorded.

[e]Depth of 6 in.

[f]Depth of ~12 in.

[g]Water at depth of 6 in.

[h]Depth of 3 in.

[i]Biased samples were collected at random and at points with slightly gamma radiation levels.

Table 4. Concentrations of radionuclides in soil samples, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Depth (cm)	Radionuclide concentration (pCi/g)[c]		
				^{238}U	^{226}Ra	^{232}Th
Systematic soil samples[d]						
VS139	13	F, 10	0-15	41 ± 2	1.0 ± 0.1	0.89 ± 0.14
VS140	13	I, 10	0-15	13 ± 1	0.89 ± 0.08	0.82 ± 0.13
VS141A	13	L, 10	0-15	53 ± 2	1.1 ± 0.1	0.99 ± 0.13
VS141B	13	L, 10	15-30	140 ± 10	1.1 ± 0.1	1.0 ± 0.1
VS142A	13	P, 10	0-15	20 ± 2	0.94 ± 0.08	0.95 ± 0.13
VS142B	13	P, 10	15-30	44 ± 2	0.95 ± 0.09	0.96 ± 0.13
VS143A	13	S, 10	0-15	20 ± 1	0.91 ± 0.08	1.0 ± 0.14
VS143B	13	S, 10	15-30	95 ± 2	0.94 ± 0.09	1.1 ± 0.15
VS144	13	V, 10	0-15	2.3 ± 0.4	0.86 ± 0.08	0.94 ± 0.13
VS145	13	V, 13	0-15	3.9 ± 0.5	0.94 ± 0.08	0.94 ± 0.13
VS146	13	S, 13	0-15	1.7 ± 0.3	0.84 ± 0.08	1.0 ± 0.1
VS147	13	P, 13	0-15	3.6 ± 0.5	0.92 ± 0.08	0.83 ± 0.13
VS148	13	L, 13	0-15	45 ± 2	0.96 ± 0.08	1.0 ± 0.1
VS149	13	I, 13	0-15	1.8 ± 0.3	0.87 ± 0.08	0.94 ± 0.12
VS150	13	P, 16	0-15	1.9 ± 0.4	0.73 ± 0.07	0.85 ± 0.11
VS151	13	S, 16	0-15	1.8 ± 0.3	0.82 ± 0.08	0.85 ± 0.14
VS152	13	V, 16	0-15	2.1 ± 0.4	0.99 ± 0.08	0.98 ± 0.13
VS153	12	G, 7	0-15	8.4 ± 0.7	0.91 ± 0.08	0.96 ± 0.13
VS154	12	I+0.5, 7	0-15	18 ± 1	0.93 ± 0.09	0.95 ± 0.13
VS155	12	L, 7	0-15	9.4 ± 0.7	1.1 ± 0.1	0.92 ± 0.12
VS156	12	P, 7	0-15	12 ± 1	0.62 ± 0.06	0.76 ± 0.11
VS157	12	L, 4	0-15	8.1 ± 0.7	0.91 ± 0.08	0.92 ± 0.12
VS158	12	I, 4	0-15	5.5 ± 0.5	0.93 ± 0.08	0.87 ± 0.12
VS159	12	G, 4	0-15	4.5 ± 0.5	0.85 ± 0.08	0.85 ± 0.11
VS160	12	I, 1	0-15	12 ± 1	0.78 ± 0.07	0.88 ± 0.12
VS161	12	P, 1	0-15	20 ± 1	0.83 ± 0.07	0.88 ± 0.13
VS162	12	T, 1	0-15	12 ± 1	0.93 ± 0.08	0.85 ± 0.12
VS163	14N	C, 1	0-15	1.4 ± 0.4	0.75 ± 0.15	0.58 ± 0.08
VS164	14N	G, 1	0-15	12 ± 1	0.60 ± 0.10	0.60 ± 0.08
VS165	14A	L, 1	0-15	2.9 ± 0.4	0.80 ± 0.18	0.48 ± 0.08
VS166	14N	L, 5	0-15	2.0 ± 0.4	0.86 ± 0.08	0.91 ± 0.13

Table 4. Concentrations of radionuclides in soil samples, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Depth (cm)	Radionuclide concentration (pCi/g)[c]		
				^{238}U	^{226}Ra	^{232}Th
VS167	14N	G, 5	0-15	1.8 ± 0.4	0.86 ± 0.08	0.92 ± 0.13
VS168	14N	C, 5	0-15	3.3 ± 0.8	0.98 ± 0.11	1.1 ± 0.2
VS169	14N	C, 9	0-15	5.5 ± 0.8	1.2 ± 0.1	1.3 ± 0.2
VS170	14N	L, 9	0-15	1.3 ± 0.4	0.89 ± 0.09	1.0 ± 0.1
VS171	14N	K, 13	0-15	2.2 ± 0.5	1.2 ± 0.1	1.1 ± 0.1
VS172	14N	G, 13	0-15	3.3 ± 0.8	0.90 ± 0.10	1.0 ± 0.2
VS173	14N	C, 14	0-15	2.7 ± 0.6	0.60 ± 0.10	0.61 ± 0.08
VS174	14N	C, 17	0-15	4.0 ± 0.7	1.4 ± 0.1	1.3 ± 0.1
VS175	14N	G, 17	0-15	3.0 ± 1.0	0.70 ± 0.15	0.85 ± 0.15
VS176	14N	L, 17	0-15	1.3 ± 0.4	1.2 ± 0.1	1.2 ± 0.1
VS 177	14S	F, 1.5	0-15	1.8 ± 0.4	0.88 ± 0.08	0.92 ± 0.12
VS178	14S	D, 7	0-15	4.5 ± 1.3	1.0 ± 0.1	0.96 ± 0.13
VS179	14S	I, 2	0-15	1.2 ± 0.4	0.81 ± 0.08	0.94 ± 0.13
VS180	9	B, 10	0-15	1.3 ± 0.3	1.1 ± 0.1	1.2 ± 0.2
VS181	9	H, 6	0-15	9.5 ± 1.0	0.89 ± 0.12	1.1 ± 0.2
VS182	9A	M, 2	0-15	0.5 ± 0.2	0.56 ± 0.08	0.28 ± 0.09
VS183	14S	C,10	0-15	1.2 ± 0.3	0.97 ± 0.12	1.3 ± 0.2
VS184	14S	F, 11	0-15	1.9 ± 0.7	1.3 ± 0.1	1.1 ± 0.2
VS185	14S	I, 14	0-15	1.5 ± 0.3	0.60 ± 0.08	0.26 ± 0.09
VS186	14S	B, 19	0-15	3.8 ± 0.5	1.0 ± 0.1	1.0 ± 0.2
VS187	14S	B, 13.5	0-15	4.5 ± 0.6	1.0 ± 0.1	1.2 ± 0.2
			Biased soil samples[e]			
VB23	20A	N(-4), E18	0-15	170 ± 20	1.6 ± 0.1	0.73 ± 0.13
VB24	20A	N0, E17	0-15	2.3 ± 0.4	1.1 ± 0.1	0.83 ± 0.10
VB25	20A	N0, E12	0-15	2.0 ± 0.4	0.94 ± 0.07	0.89 ± 0.10
VB26	20A	N0, E7	0-8	9.8 ± 1.0	1.0 ± 0.1	0.37 ± 0.07
VB27	20A	N0, E1	0-8	5.4 ± 1.0	1.0 ± 0.1	0.51 ± 0.09
VB28	20A	N1, E3	0-15	0.63 ± 0.19	0.50 ± 0.05	0.28 ± 0.06
VB29	20A	N1, E18	0-15	1.4 ± 0.3	1.6 ± 0.1	0.95 ± 0.12

Table 4. Concentrations of radionuclides in soil samples, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Depth (cm)	Radionuclide concentration (pCi/g)[c]		
				^{238}U	^{226}Ra	^{232}Th
VB30	13	L, 12.5	0-15	3.5 ± 0.4	3.0 ± 0.1	0.93 ± 0.16
VB31	13	H, 15	0-15	30 ± 1	0.78 ± 0.20	0.39 ± 0.11
VB32	12	L, 1	0-15	33 ± 1	0.99 ± 0.13	0.91 ± 0.18
VB33A	12	W, 0	0-15	90 ± 10	0.90 ± 0.15	1.1 ± 0.2
VB33B	12	W, 0	15-30	55 ± 10	0.82 ± 0.13	1.1 ± 0.2
VB34	12	N, 3.5	0-15	36 ± 2	0.96 ± 0.14	0.77 ± 0.22
VB40[f]	14A	G, 5	0-15	39 ± 5	0.85 ± 0.10	0.80 ± 0.20
VB41	14A	I, 5	0-15	70 ± 15	0.90 ± 0.15	0.77 ± 0.10
VB42	14N	K, 12.5	0-15	2.1 ± 0.4	0.90 ± 0.10	0.80 ± 0.10
VB43	9C	C, 1	0-15	670 ± 70	2.0 ± 0.2	1.3 ± 0.3
VB45[f]	14SE	D, 15	0-15	4.8 ± 0.6	1.0 ± 0.1	1.2 ± 0.2

[a]Sample locations are shown on Fig. 4.

[b]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0). In most rooms the number of meters north is indicated by a letter (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and the number of meters east by a number.

[c]Indicated counting error is at the 95% confidence level (±2F).

[d]Systematic samples were collected in a systematic manner without regard to gamma radiation levels.

[e]Biased samples were collected at random and at points with slightly gamma radiation levels.

[f]No samples numbered VB35–VB39 or VB44.

Table 5. Transferable alpha and beta-gamma measurements at Building 14, former Linde Uranium Refinery, Tonawanda, New York

Smear sample ID	Location	Date smear collected	Removable radioactivity (smears)	
			Alpha[a] (dpm/100 cm^2)	Beta-gamma[b] (dpm/100 cm^2)
VT50	Large hallway, east wall	9-16-97	[0]	[!28]
VT51	Large hallway, west wall	9-16-97	[0]	[!11]
VT52	Area 4, 2 m east of SW corner	9-18-97	[0]	[!39]
VT53	Area 4, 3 m north of E wall	9-18-97	[0]	[0]
VT54	Large hallway; N0, E3[c]	9-18-97	[0]	[!6]
VT55	Large hallway; south wall; N0, E17; beam[c]	9-18-97	[0]	[!28]
VT56	Area 2; N3.5, E5[c]	9-18-97	[0]	[–17]
VT57	Area 2; N3.5, E9[c]	9-18-97	[0]	[17]
VT58	Area 15, 15A	11-12-97	[!7]	[!45]
VT59	Area 15, 15A	11-12-97	[!7]	[25]
VT60	Area 15, 15A	11-12-97	[0]	[0]
VT61	Area 15, 15A	11-12-97	[0]	[!65]
VT62	Area 15, 15A	11-12-97	[0]	[!90]
VT63	Area 15, 15A	11-12-97	[!7]	[!40]
VT64	Area 15, 15A	11-12-97	[!7]	[–10]

Table 5. Transferable alpha and beta-gamma measurements at Building 14, former Linde Uranium Refinery, Tonawanda, New York

Smear sample ID	Location	Date smear collected	Removable radioactivity (smears)	
			Alpha[a] (dpm/100 cm^2)	Beta-gamma[b] (dpm/100 cm^2)
VT65	Area 15, 15A	11-12-97	[7]	[!40]
VT66	Area 15, 15A	11-12-97	[7]	[!35]
VT67	Area 15, 15A	11-12-97	[!7]	[0]
VT70	Area 14N, overhead beam	1-13-98	[0]	[!22]
VT71	Area 14N; H, 9[d]	1-14-98	[0]	[28]
VT72	Area 14N; D, 2[d]	1-14-98	[0]	[!39]

[a]MDA for alpha activity = 9 dpm/100 cm^2.

[b]MDA for beta activity = ~125 dpm/100 cm^2.

[c]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0).

[d]Grid location with number of meters north of southwest corner of room indicated by a letter. (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and number of meters east by a number.

Note: All values represent the actual measurement less the background response of the detector used. A value in brackets [##] indicates that the measurement was not discernable from the background response of the detector (95% confidence).

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
		Second floor	
2nd floor	4-14-97	•Surveyed ~60% of overhead areas and ~50% of wall area. No areas elevated above guidelines. - Overheads 600–2300 dpm/100 cm^2. - Walls 600–1500 dpm/100 cm^2. •2nd floor added after Manhattan Engineering District activities. No contamination suspected on floors and internal walls that have not been surveyed. •2nd floor completed	
2nd floor	4-15-97	•Random FIDLER measurements. Nothing above typical background. Completes 2nd floor.	2nd floor 5-5-97
		First floor	
2, 3, 4, & large hallway	9-15-97 9-16-97	•Walls surveyed. No elevated areas.	
2	9-15-97 9-16-97	•Overheads 300–1800 dpm/100 cm^2. •Walls 1200–2100 dpm/100 cm^2. •Floor monitor. No anomalies. •Beta-gamma pancake survey 600–1800 dpm/100 cm^2. •Smears VT56, VT57.	Area 2 10-27-97
3	9-15-97	•Walls 750–1800 dpm/100 cm^2. •No anomalies.	
3	9-18-97	•Floors, 600–1500 dpm/100 cm^2; corners and edging 600–1800 dpm/100 cm^2. •Overheads 600–1200 dpm/100 cm^2. •No anomalies.	Area 3 10-27-97
4	9-15-97 9-16-97	•Overheads, 900–2100 dpm/100 cm^2. •Walls, 750–1800 dpm/100 cm^2. •Floors, 600–1800 dpm/100 cm^2; smears VT52 and VT53. •No anomalies.	Area 4 10-27-97

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
Large hallway (north of Area 4)	9-15-97 9-16-97	•Surveyed with floor monitor. No anomalies. •Results of beta-gamma pancake survey: - Overheads 600–3600 dpm/100 cm^2. - Walls 1200–1800 dpm/100 cm^2. - Floor-wall interface 900–1800 dpm/100 cm^2. - 2 floor anchors 24,000 dpm/100 cm^2 and 27,000 dpm/100 cm^2. (Removed by IDM.) •Smears VT50, VT51, VT54. •IDM poured a slushy concrete mix (fillable flow) into excavated pits and trenches located in large hallway area. Previously verified data sent by IDM.	Large hallway 10-27-97
5A 5B 5C1 5C2 5C3 5D 5D1 5D2 Ladies Hallway	9-15-97 9-16-97	•Overheads this area built after Manhattan Engineering District activities ceased. Not surveyed. •Walls and floors generally 900–2100 dpm/100 cm^2. Specifics all below guidelines: - 5A, 2 small spotty areas ~14 in. × 20 in., ~3300–4800 dpm/100 cm^2. - Stairwell south of 5A, area ~15 in. × 10 in., spotty 1800–3300 dpm/100 cm^2. - 5B, spot on outside wall 1400–2200 dpm/100 cm^2. - 5C2, spot on outside wall 600–2300 dpm/100 cm^2. - East wall of hall, know area 11,000–12,000 dpm/100 cm^2 under wall ledge. Considered part of Area 9 and remediated during cleanup of Area 9.	Offices, ladies' room, hallway 10-27-97
7A 7B 7C 7D Men's Room	9-16-97 9-17-97	•Overheads this area built after Manhattan Engineering District activities ceased. Not surveyed. •Surveyed this area with floor monitor and beta-gamma pancake detector. •General range walls and floors 600–800 dpm/100 cm^2. •Room 7B, 1 anomaly 1800–3300 dpm/100 cm^2 inside larger area 3300–7800 dpm/100 cm^2.	Offices, men's room 10-27-97
8A	9-15-97 9-16-97	•Walls, floors 750–2100 dpm/100 cm^2.	
8A	6-2-98	•Overheads surveyed with Area 9, generally 300–1800 dpm/100 cm^2. No areas near guidelines.	Ceilings 6-10-98 (with Area 9)

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
8A	7-16-98	•Floor and 3 walls below guidelines, 300–1200 dpm/100 cm^2.	Other areas 9-16-98 (with Area 9)
8	4-14-97	•Completed accessible overhead area (~30% area blocked); 600–1800 dpm/100 cm^2.	
8	4-15-97	•Blocked area cleared. Completed survey. - Floors 600–2700 dpm/100 cm^2. - Overheads 600–1800 dpm/100 cm^2 with one spot 11,000 dpm/100 cm^2. This is a small spot that meets guidelines.	Above-ground surfaces 5-5-97; Subsurface 10-27-97
8, 10, 11	4-15-97	•FIDLER measurements on 2-m grid. Results provided 2 sampling locations for IDM	Above-ground surfaces 5-5-97; Subsurface 10-27-97; Remaining areas 7-7-98
9 Lab	6-2-98	•Overheads. - Scaffolding erected with walkboards. - ~40% of horizontal surfaces surveyed concentrating on I-beams and other structures most likely in place during Manhattan Engineering District activities. - Much of 9 Lab overhead inaccessible due to ventilation system. - Generally 300–1800 dpm/100 cm^2. Few spots 4800–6300 dpm/100 cm^2. No areas near guidelines.	Ceilings and overheads 6-10-98

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
9	7-9-98	•Surveyed floor and subsurfaces, 13–16 FR/h. Below guidelines with the following exceptions. - Floor underneath two large hoods on east side of room will remain as contaminated surfaces.[d] - Room 9B, ~3-m^2 area on N wall up to 17,000 dpm/100 cm^2; typically 9000–11,000 or 12,000 dpm/100 cm^2. (Wall removed by IDM.) - Room 9D, end of one pipe = 71,000 dpm/100 cm^2. (Not cost-effective to remove.[d]) - Area on south wall at location A, 10 ranged up to 32,000 dpm/100 cm^2 (generally 11,000–17,000 dpm/100 cm^2). (Wall removed by IDM.) - 4 lead anchors up to 53,000 dpm/100 cm^2; lots of non-contaminated lead anchors. (Removed by IDM.) - Column at location D, 9 contaminated around base 17,000–44,000 dpm/100 cm^2. (Removed by IDM.) - Hottest spot in trench = 23 FR/h, 130,000 dpm/100 cm^2. (Removed by IDM.) - Biased soil sample VB43 containing 670 pCi/g ^{238}U collected at this location (C, 1). (Area excavated further by IDM.) - Systematic soil samples VS180–VS182 collected in Area 9; VS181 contained 9.5 pCi/g ^{238}U; others similar to typical background.	
9	7-16-98	•After additional excavation, IDM supplied soil sample data to ORNL for verification. •Inside walls with associated contamination had been removed by IDM.	Exposed soil, concrete floor, walls 9-16-98; Soil samples 10-23-98
10	4-14-97	•Surveyed ~50% of overheads, ~70% of floors, and 1 m up on wall. - Floors 600–3600 dpm/100 cm^2. - Overheads 600–1800 dpm/100 cm^2. - Walls, 2 spots with elevated measurements within guidelines. No action needed. (1) East wall upper horizontal surface, 1 m × 30 cm = 5000 dpm/100 cm^2. (2) South wall upper horizontal surface 1 cm × 75 cm = 5000–7500 dpm/100 cm^2.	Above-ground surfaces 5-5-97 Subsurface 10-27-97
11	4-14-97	•Surveyed ~50% of overheads, ~70% of floors, and 1 m up on wall. - Floors 600–2700 dpm/100 cm^2. - Overheads 600–1800 dpm/100 cm^2.	

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
11	4-15-97	•Surveyed 30% walls. No anomalies	Above-ground surfaces 5-5-97; Subsurface 10-27-97
Corridor	8-28-97	•Floor (300–1500 with exception of a few elevated areas that will be remediated) below guidelines. •Walls 1800-2700 due to high background from brick. •Overheads 0–900 dpm/100 cm^2 (only looked at certain areas).	10-27-97 7-7-98
Stairwell leading to utility tunnel in Area 12	5-4-98	•0–1200 dpm/100 cm^2. •Overhead electrical conduits elevated on top of the steam line. IDM will remediate.	5-20-98 9-21-98
Stairwell leading to utility tunnel		•Walls, stairs, floor, ceiling, and electrical conduits.	10-23-98
Pipes in utility tunnel near Area 12	5-6-98	•IDM to conduct more decon work on pipes in this area. After decon, IDM supplied data to ORNL for verification.	9-21-98
Pipe in Area 12 sump (tunnel access)	7-16-98	•Re-surveyed after decon, 300–1800 dpm/100 cm^2; highest spot 3300 dpm/100 cm^2.	9-21-98

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
Sump in utility tunnel		•Reviewed IDM data. •Released surface of sump and east and west drain lines. •North drain line exceeds DOE criteria.[d]	11-10-98
12	4-15-97	•High bay room with 30-ft ceilings. •Floor and floor-wall interfaces contaminated. This will be removed to access subsurface contamination. •Surveyed walls and overheads (50-60% of overheads). - Hot spot above guidelines on lower horizontal surface of upper I-beam (overheads on west wall).[d] - Ledge on the west wall with several areas on upper horizontal surfaces above guidelines. Will be demolished with the floor. (Removed.)	Surface above 1 ft of floor-wall interface 5-5-97
12 & 13	7-15-97	•Gamma scan, 4 biased soil sampling locations identified.	
12 &13	7-16-97	•Beta-gamma scan of edges of footers. •Began taking soil samples.	
12 & 13	7-17-97	•Highest count rate where can access underside of concrete; maximum 37,000 dpm/100 cm^2 at location J+0.5, 1. •Several spots along west knee wall 5000–10,000 dpm/100 cm^2. (Approved as above-guideline area.[d]) •Southwest corner, concrete at wall-floor interface 25,000 dpm/100 cm^2. (Removed) •One area soil contamination identified and remediated by IDM.	Area 12 &13 subsurface & remaining floor 7-30-97; Area 12 10-27-97

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
13	3-4-96 3-5-96	•Using man lift, surveyed overheads including cranes, trusses, and supports. 30-ft ceiling and several pieces of equipment hindered mobility. Generally, west side of beams against west wall >5000 dpm/100 cm^2, and rivets at junctions above criteria. Contamination noted [beams and junctions numbered for reference (see site sketch on data sheet)]: - Steel plate between western most north-to-south I-beam and west wall; area = ~108 ft^2; loose dust and debris up to 8000 dpm/100 cm^2. - Steel place/brace connecting crossbeams at ceiling-wall interface (west face); area = 0.3 m^2; 11,000 dpm/100 cm^2. - Junction coupling plate (rivets) at junction #5; area = 500 cm^2; 11,000 dpm/100 cm^2. - Steel place/brace, rivet area coupling crossbeams at ceiling-wall interface (western face); area = 0.3 m^2; 35,000 dpm/100 cm^2. - Brace south side of beam #2 at crane-rail interface; area = 600 cm^2; 58,000 dpm/100 cm^2. - Brace/beam support at west wall ~2.5 ft above crane support top; area = ~700 cm^2 (riveted area); 21,000 dpm/100 cm^2. - Crossbeam south of junction 6 western face; area = 100 cm^2; 20,000 dpm/100 cm^2. - Riveted area west of beam #9 and north of beam 3; area = ~400 cm^2; 17,000 dpm/100 cm^2. - I-beam running north to south, I-beam #10; 0.1 by 1.5 m; average 6300 dpm/100 cm^2, up to 7800 dpm/100 cm^2. - Location #3 ~1 m down from ceiling, painted white; area = 100 cm^2; 15,000 dpm/100 cm^2. - Center brace for long crossbeam running from #5 at west wall to #8 at east wall; area = 500 cm^2; 23,000 dpm/100 cm^2. - North of junction #1 on crossbeam; area ~500 cm^2; 23,000 dpm/100 cm^2. - South of junction #1 on crossbeam; area = ~200 cm^2; 23,000 dpm/100 cm^2. •Floors and baseboards checked; floors, baseboards, and north wall need further decontamination. •NOTE: This was the first area surveyed in Bldg. 14. A new remediation contractor (IDM Environmental Corp) took over cleanup activities after this date.	
13	4-16-97	•Surveyed walls and overheads (50–60% overheads). - Crain rail approved for above-guideline area.[d] •Checked floors and floor-wall interfaces.	7-30-97 7-7-98

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
14N	1-13-98	•Began survey of overheads. Generally 600–1800 dpm/100 cm^2. - Spot on I-beam (at D, 2) 17,000 dpm/100 cm^2. See smear VT72. - Spot on cross member (at H, 9) 17,000 dpm/100 cm^2. See smear VT71. - Small spot ~20 cm^2 (at C, 14) 14,000 dpm/100 cm^2. Will average. See smear VT70.	
14N	1-14-98	•Overheads scanned. •Lower portion of walls scanned.	
14N	1-15-98	•Completed survey of ~50% of overheads concentrating on probable areas of contamination (i.e., horizontal surfaces, bolts, cross members). •Surveyed bottom 3 meters of walls (~30%). - Walls range from 300–1800 dpm/100 cm^2 with an area ~2600 dpm/100 cm^2.	All surfaces above 6 in. from floor-wall interface 1-30-98
14SW	1-16-98	•Surveyed lower areas to ~10 ft up wall (600–1800 dpm/100 cm^2). •Anchor bolts 2700–3300 dpm/100 cm^2.	
14N 14SW	3-4-98	•Surveyed soil and lower portion of wall this trip. •Several areas along the knee wall (concrete surface and soil underneath) above criteria. These have also been identified by IDM and are to be included in the hazard assessment. •Soil scanned with NaI detector; 3 biased soil sample locations identified. •Collected 3 biased soil samples and 15 systematic samples. •Scanned lower portion of wall (up to ~10 ft). •Conferred with IDM (remediation contractor). Elevated soil on 14N–14SW boundary to be removed overnight. Area will be ready for verification tomorrow.	14N and 14SW subsurface and remaining floor 3-16-98
14SW	3-4-98	•Contaminated concrete ledge 20 ft up bordering 14SE (area with 55-ft ceiling) will be removed with decon of 14SE.	
14SE 14SW	3-5-98	•Completed surface surveys and soil sampling.	14SE 6-10-98
14SW	5-4-98	•Overheads (not ceiling) 0–1200 dpm/100 cm^2. - NW corner (overheads) on a former window sill, crack in concrete ~4000–7000 dpm/100 cm^2.	

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
14SW	5-5-98	•Overheads (I-beams and cross members) surveyed with lift. - ~50% coverage. - All areas clean except the lower horizontal surfaces of I-beams closest to the wall. Areas will be added to hazard assessment.	14SW areas 12 ft above floor 5-20-98; Ceilings 6-10-98
14SW 14SE	6-1-98	•Surveyed ~35–40% of ceiling (55-ft ceiling in Area 14SW) using scissor lift, generally 300–1800 dpm/100 cm^2. - Found one slightly elevated area (2400–3000 dpm/100 cm^2) and one significantly elevated area (3300–59,000 dpm/100 cm^2) located on the uppermost I-beam on the N wall. Contamination covered ~10–15 ft on horizontal (lower) surface. IDM chiseled away the significantly contaminated area.	14SW accessible areas above 6 in. from floor-wall interface 1-30-98
14SE	6-3-98	•Overheads and walls. - After climbing 25–30 ft on scaffolding, decided unsafe. - Reviewed IDMs post-remedial action survey data.	10-10-98; Ceilings 10-23-98
14S	7-8-98	•Surveyed above the bridge crane, ~25% of horizontal surfaces and cracks and crevices likely to contain contamination. The following spots and small areas were noted. All are below guidelines. - Spot in NW corner, ~500 cm^2 = 12,000 dpm/100 cm^2. - NW corner, horizontal on I-beam, ~4 ft × 10 cm = 3300 dpm/100 cm^2. - Spot at NW wall = 1600 dpm/100 cm^2. - Spot at N center wall, <100 cm^2 = 3800 dpm/100 cm^2 (smear showed no transferable contamination). - Along N wall, generally 900–2400 dpm/100 cm^2 (red brick). - Spot at NE wall = 1600 dpm/100 cm^2. - W ceiling vent = background. - E ceiling vent = 900–2100 dpm/100 cm^2. - SE, 2-ft × 4-ft area = 5000 dpm/100 cm^2. - SE, area 18 in. × 3 in. = 10,000–15,000 dpm/100 cm^2 (smear showed no transferable contamination).	
14SE	7-16-98	•Gamma scan of floor and subsurface (11–13 FR/h). •Systematic samples VS183–VS187 and biased sample VB45 (13 FR/h) collected this date. •Remaining floor scanned with beta-gamma pancake detector (300–2400 dpm/100 cm^2). •One area above guidelines. This area to be chipped and IDM to take additional HP data.	

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
14		•Soil samples cleared	10-23-98
15	11-10-97	•Gamma scan 10–13 FR/h, 14 FR/h in corner geometry. •Beta-gamma scan of floor-wall interfaces; small spot 2500 dpm/100 cm^2; No contamination above guidelines. •Surveyed all accessible floor areas with floor monitor; one area 15,000 dpm/100 cm^2; remediated by IDM. •~33% of overheads surveyed; 600-3300 dpm/100 cm^2. •Began wall scan.	
15	11-11-97	•Continued survey of overheads and walls. •Surveyed pit in southern end of area. •Released 11-12-97	12-12-97
15A	11-11-97	•Contamination on column adjacent to Area 15 (10,000–15,000 dpm/100 cm^2) covering area of ~½ m^2. •Cleaned up by IDM. Cleared 11-12-98. •Completed walls. •Took smears and alpha measurements	
15A 15B1 15B	11-12-97	•Need IDM data on overhead.	
15A	11-12-97	•Need IDM data on drain and pit.	
15A	11-12-97	•Completed overhead scan.	
15B-1	11-12-97	•One spot 15,000 dpm/100 cm^2. Cleaned up by IDM.	
15B-1	11-12-97	•Checked drain near 15B-1. No contamination detected. •Finished overheads. Overhead area cleared.	

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
15A, 15B, 15B-1		•Interior surfaces and subsurface cleared	Interior surfaces and subsurfaces cleared 12-22-97
20A	7-18-96	•Survey of remaining concrete floor and exposed subsurface area. Area cluttered by equipment, tools, and storage shelves. Areas of note: - 2-ft by 15-ft area on concrete floor at base of north wall with 4 to 6 spots >15,000 dpm/100 cm^2. Recommend remediation. - Subsurface area in southeast corner 18 FR/h; 14,000 dpm/100 cm^2 appears to continue north and east of corner. - Subsurface trench generally 3300–5100 dpm/100 cm^2. - Plastic cover on pipe in trench 15,000 dpm/100 cm^2. - 0N, 7E vertical pipe, ~3 in., 16,000 dpm/100 cm^2.	7-7-98
20A East	10-28-96 10-29-96	•No elevated areas.	12-30-96 7-7-98
20A West		•Review of IDM data.	1-30-98
20B 20B-1	10-28-96 10-29-96	•Surveyed ~50% floor and wall surfaces. No elevated areas.	12-30-96 7-7-98
20C	10-28-96 10-29-96	•No elevated areas.	12-20-96 7-7-98
21	2-5-98	•Obtained background information on activities conducted in the 2 sumps. Toured area. •Sumps removed and excavated down to 12–15 ft. •Reviewed data from IDM. •IDM split soil samples sent to ORNL for analysis.	7-7-98 9-21-98

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
Bldg. 14	5-6-98	Meeting to decide on placement of radon chambers.	
Bldg. 14	5-28-98	Radon detectors placed by Doug Davis of SEC and Steve Nakasaki of BNI.	

BNI = Bechtel National, Inc., remediation contractor.
FIDLER = field instrument for the detection of low-energy radiation.
IDM = IDM Environmental Corporation, remediation turnkey subcontractor.

[a]Area numbers shown on Fig. 3. No second floor drawing shown.

[b]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0). In most rooms the number of meters north is indicated by a letter (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and the number of meters east by a number.

[c]See correspondence in Appendix D.

[d]See "Summary of Locations Exceeding Remedial Action Criteria" in Appendix A.

Table 7. Results of radon measurements in indoor air at Building 14, former Linde Uranium Refinery, Tonawanda, New York

Location in Building 14 (see Fig. 5)	Electret serial number	Start date	Stop date	Total time hours (days)	Radon concentration (pCi/L)	Radon concentration[a] (WL)
Areas 2 and 3	SR5034	5-28-98	6-29-98	775.9 (~32)	1.1	0.0055
Area 4B	SR5119	5-28-98	6-29-98	775.8 (~32)	1.5	0.0075
First floor offices, 5A	SO6225	5-28-98	6-29-98	775.4 (~32)	0.7	0.0035
First floor offices, 5A		5-28-98	6-29-98	768.2 (~32)	0.5	0.0025
Frist floor offices, 5B	SR5026	5-28-98	6-30-98	792.9 (~33)	0.4	0.002
First floor offices, 5C2	SO6122	5-28-98	6-29-98	775.5 (~32)	1.2	0.006
First floor offices, 5C3	SO6152	5-28-98	6-29-98	775.5 (~32)	0.6	0.003
Small Hallway	SR5168	5-28-98	6-29-98	775.9 (~32)	0.5	0.0025
Area 8	SR5182	5-28-98	6-29-98	776.1 (~32)	1.2	0.006
Area 9	SO6149	8-26-98	9-28-98	787.3 (~33)	1.1	0.0055
Area 9 (duplicate)	SO6275	8-26-98	9-28-98	787.3 (~33)	0.8	0.004
Corridor	SO6323	8-26-98	9-28-98	787.1 (~33)	1.2	0.006
Area 13	SR5233	5-28-98	6-29-98	776.2 (~32)	0.9	0.0045
Area 13 (duplicate)	SR5199	5-28-98	6-29-98	775.2 (~32)	0.8	0.004
Area 14-North	SO6157	8-26-98	9-28-98	787.2 (~33)	0.6	0.003
Area 14-South	SO6245	9-10-98	9-28-98	427.4 (~18)	1.6	0.008
Area 15	SO6126	5-28-98	6-29-98	775.8 (~32)	0.7	0.0035
Area 20A-East	SR5229	5-28-98	6-29-98	775.7 (~32)	1.2	0.006
Area 20A-West	SR5013	5-28-98	6-29-98	775.8 (~32)	0.7	0.0035
Area 20B	SR5225	5-28-98	6-29-98	775.8 (~32)	0.5	0.0025

[a]Working level (WL) measurements were not performed. The listed values were estimated using the assumption that the concentration of radon progeny in room air was equal to 50% of the measured ^{222}Rn concentration.

APPENDIX A

SUMMARY OF LOCATIONS EXCEEDING REMEDIAL ACTION CRITERIA

A number of locations were identified where residual contamination exceeding the remedial action criteria remained after decontamination efforts. These locations occur in Areas 9, 12, 13, 14 North, 14 South, 15, 20A East, and 21. Contamination exceeding the criteria was left in place only after all best efforts at decontamination were made and the criteria for supplemental limits were carefully evaluated. These locations fall into several categories. The first category includes areas of soils underlying building walls in Areas 12, 13, 14 North, and 14 South where further removal would undermine the walls and place the structural integrity of the building at risk. A second type, which occurred at five locations in Area 14 South, is on the sill of a beam adjacent to walls where limited access by remediation equipment prevented complete decontamination. Similarly, on the crane rails in Areas 12, 13, and 14 North, restricted access prevented full decontamination around bolt heads. Four floor locations in Areas 9, 14 South, and 15 were inaccessible because of the presence of large equipment. Based on data from surrounding floor measurements, these locations were estimated to exceed guidelines. Interior wall contamination exceeding remedial action criteria in the south wall of Area 14 South was discovered. Several subsurface drainpipes in Area 9, the Area 12 stairwell sump, Area 20A East, and the existing in-bed drainline system that was left in place contained contamination exceeding remedial action criteria. This determination was based on survey measurements obtained at locations where drainlines were exposed during remediation of sumps or pipes. Portions of the drainline were removed during the remedial action, but most of the potentially contaminated drainline system remain in place. (Excerpt from Executive Summary in *Post-Remedial Action Report for Building 14 at the Linde Site, Tonawanda, New York*, June 1999.)

Pages A-4 through A-8 provided in hard copy.

APPENDIX B

PROCESS PIPING RADIOLOGICAL INVESTIGATION

Pages B-3 through B-14 provided in hard copy.

APPENDIX C

FIDLER MEASUREMENTS

Table C.1. FIDLER measurements with Detector A003Y at Building 14
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
8	0	5	12,352	4-15-97	A003Y
8	2	5	11,941	4-15-97	A003Y
8	4	5	12,561	4-15-97	A003Y
8	6	5	12,720	4-15-97	A003Y
8	8	5	11,450	4-15-97	A003Y
8	10	5	11,988	4-15-97	A003Y
8	12	5	8,900	4-15-97	A003Y
8	14	5	9,158	4-15-97	A003Y
8	4	1	12,308	4-15-97	A003Y
8	6	1	13,051	4-15-97	A003Y
8	8	1	12,245	4-15-97	A003Y
8	10	1	12,353	4-15-97	A003Y
8	12	1	11,047	4-15-97	A003Y
10	14	12	11,178	4-15-97	A003Y
10	0	10.5	11,517	4-15-97	A003Y
10	2	10.5	11,268	4-15-97	A003Y
10	4	10.5	12,062	4-15-97	A003Y
10	6	10.5	11,990	4-15-97	A003Y
10	8	10.5	11,086	4-15-97	A003Y
10	10	10.5	10,317	4-15-97	A003Y
10	1	1	8,527	4-15-97	A003Y
10	1	3	9,600	4-15-97	A003Y
10	1	5	9,787	4-15-97	A003Y
10	1	7	8,875	4-15-97	A003Y
11	5	7	10,127	4-15-97	A003Y
11	5	5	10,719	4-15-97	A003Y
11	5	3	10,164	4-15-97	A003Y
11	5	1	9,731	4-15-97	A003Y

Table C.1. FIDLER measurements with Detector A003Y at Building 14
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
20B/20B-1	0	9	9,203	10-28-96	A003Y
20B/20B-1	0	8	8,807	10-28-96	A003Y
20B/20B-1	0	7	8,594	10-28-96	A003Y
20B/20B-1	0	6	6,801	10-28-96	A003Y
20B/20B-1	0	5	10,331	10-28-96	A003Y
20B/20B-1	0	4	9,862	10-28-96	A003Y
20B/20B-1	0	3	7,486	10-28-96	A003Y
20B/20B-1	0	2	9,916	10-28-96	A003Y
20B/20B-1	0	1	8,407	10-28-96	A003Y
20B/20B-1	0	0	8,396	10-28-96	A003Y
20B/20B-1	3	9	8,296	10-28-96	A003Y
20B/20B-1	3	8	6,974	10-28-96	A003Y
20B/20B-1	3	7	8,499	10-28-96	A003Y
20B/20B-1	3	6	9,180	10-28-96	A003Y
20B/20B-1	3	5	8,821	10-28-96	A003Y
20B/20B-1	3	4	8,801	10-28-96	A003Y
20B/20B-1	3	3	6,806	10-28-96	A003Y
20B/20B-1	3	2	9,253	10-28-96	A003Y
20B/20B-1	3	1	9,489	10-28-96	A003Y
20B/20B-1	3	0	9,212	10-28-96	A003Y
20B/20B-1	4	0	8,590	10-28-96	A003Y
20B/20B-1	4	1	9,284	10-28-96	A003Y
20B/20B-1	4	2	8,779	10-28-96	A003Y
20B/20B-1	4	3	8,183	10-28-96	A003Y
20B/20B-1	4	4	8,477	10-28-96	A003Y

[a]Measurements from Detector A003Y can only be compared with other measurements from the same detector.
[b]Meters north and east of southwest corner (N0, E0).

Table C.2. FIDLER measurements with Detector A005Y at Building 14
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
8	0	7	15,094	4-15-97	A005Y
8	2	7	13,837	4-15-97	A005Y
8	4	7	15,338	4-15-97	A005Y
8	6	7	14,472	4-15-97	A005Y
8	8	7	13,241	4-15-97	A005Y
8	10	7	12,877	4-15-97	A005Y
8	2	3	11,592	4-15-97	A005Y
8	4	3	14,447	4-15-97	A005Y
8	6	3	13,681	4-15-97	A005Y
8	8	3	11,130	4-15-97	A005Y
8	10	3	12,741	4-15-97	A005Y
8	12	3	11,464	4-15-97	A005Y
8	14	3	10,668	4-15-97	A005Y
10	0	12	12,460	4-15-97	A005Y
10	2	12	12,721	4-15-97	A005Y
10	4	12	13,681	4-15-97	A005Y
10	6	12	13,342	4-15-97	A005Y
10	8	12	12,062	4-15-97	A005Y
10	10	12	13,266	4-15-97	A005Y
10	2	8	12,704	4-15-97	A005Y
10	4	8	13,581	4-15-97	A005Y
10	6	8	13,841	4-15-97	A005Y
10	8	8	13,457	4-15-97	A005Y
10	10	8	13,121	4-15-97	A005Y
11	3	8	9,536	4-15-97	A005Y
11	5	8	11,008	4-15-97	A005Y
11	7	8	10,685	4-15-97	A005Y
11	9	8	10,145	4-15-97	A005Y

Table C.2. FIDLER measurements with Detector A005Y at Building 14
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
20B/20B-1	1	9	10,451[c]	10-28-96	A005Y
20B/20B-1	1	8	8,051	10-28-96	A005Y
20B/20B-1	1	7	9,807	10-28-96	A005Y
20B/20B-1	1	6	7,486	10-28-96	A005Y
20B/20B-1	1	5	9,877	10-28-96	A005Y
20B/20B-1	1	4	10,112[c]	10-28-96	A005Y
20B/20B-1	1	3	7,070	10-28-96	A005Y
20B/20B-1	1	2	10,772	10-28-96	A005Y
20B/20B-1	1	1	10,909	10-28-96	A005Y
20B/20B-1	1	0	10,955	10-28-96	A005Y
20B/20B-1	2	0	10,508[c]	10-28-96	A005Y
20B/20B-1	2	1	10,386	10-28-96	A005Y
20B/20B-1	2	2	10,411[c]	10-28-96	A005Y
20B/20B-1	2	3	7,139	10-28-96	A005Y
20B/20B-1	2	4	9,797	10-28-96	A005Y
20B/20B-1	2	5	9,456	10-28-96	A005Y
20B/20B-1	2	6	6,964	10-28-96	A005Y
20B/20B-1	2	7	8,676	10-28-96	A005Y
20B/20B-1	2	8	8,739	10-28-96	A005Y
20B/20B-1	2	9	7,726[c]	10-28-96	A005Y
20B/20B-1	4	9	8,911[d]	10-28-96	A005Y
20B/20B-1	4	8	9,363	10-28-96	A005Y
20B/20B-1	4	7	9,810	10-28-96	A005Y
20B/20B-1	4	6	8,026	10-28-96	A005Y
20B/20B-1	4	5	9,588	10-28-96	A005Y

[a]Measurements from Detector A005Y can only be compared with other measurements from the same detector.
[b]Meters north and east of southwest corner (N0,E0).
[c]Near wall.
[d]Corner

APPENDIX D

CORRESPONDENCE

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